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4D tracking results with the Timepix4 telescope

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A high rate beam telescope based on the Timepix4 ASIC has been built to evaluate novel pixel sensors with high spatial and temporal resolution. Moreover, the telescope can also be used for tests of synchronous multiple-detector readout and track reconstruction with fast timing capability (i.e. 4D tracking demonstrator).

The telescope consists of eight planes with n-on-p silicon sensors, each bump bonded to a Timepix4 ASIC. Four of these planes are instrumented with $300\mu\text{m}$ thick planar sensors, which are tilted with respect to the beam to improve the track pointing resolution. The other four planes have $100\mu\text{m}$ thick sensors and are perpendicular to the beam to provide the best track time resolution.

The Timepix4 is designed to record both the time of arrival (ToA) and the time over threshold (ToT) for each discriminated signal. It has a 448×512 pixel matrix with square pixels at a $55\mu\text{m}$ pitch. Each superpixel, a group of two by four pixels, has a 640 MHz voltage controlled oscillator (VCO). The VCO provides four phase shifted copies of the 640 MHz clock, which results in a ToA digitisation with time bins of 195 ps. The ToT is proportional to the charge collected by the silicon sensor, and is used to improve spatial resolution based on charge sharing. The ToT is also used to correct for timewalk and thereby improve the ToA resolution. After VCO and timewalk corrections a time resolution of 160-180 ps is achieved for each of the thin planes. The measurements are combined to achieve a more precise time stamp of a track of about 90 ps. In this presentation an overview of the telescope capabilities is given, and the most recent results of the temporal and spatial resolutions obtained by the telescope will be shown.

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